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ABSTRACT

A model, derived from the literature, is presented of the influence of learners' preconceptions on the amount of mental effort invested in learning from television. The proposed model suggests that learners' preconceptions are influenced by the characteristics of the media, the characteristics of the task, and the characteristics of the learner. The theoretical and research basis of these proposed relationships is reviewed. In general, research on learners' preconceptions of television and video indicates that learners perceive television as an easy medium, believe that it requires little mental effort, and think that they would learn little from a video-based lesson. However, their preconceptions may change as they become more experienced. Learners appear to make a decision about the difficulty of the task, decide how much effort to exert in processing the lesson, and modify their effort expenditures if characteristics of the lesson differ from those expected. Practical implications of the proposed model for instructional design are considered, and needs for further research are outlined. (Contains 36 references.) (SLD)

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Title:

Learning From Video: The Influence of Preconceptions on Invested Mental Effort

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Learning from video:
The influence of preconceptions on invested mental effort

The fact that those who frequently watch television are referred to as "couch potatoes" indicates that American society accepts, and in fact expects, viewers to adopt a passive stance toward television viewing. Although a passive response to television may be beneficial when the goal of the individual is relaxation, the viewers' preconceptions of television as an easy, passive medium may interfere with their learning from the medium, and thus be detrimental to the use of television and videotapes for instruction.

In an often-cited study, Salomon (1984) measured learners' preconceptions of the ease or difficulty of print and television, then the learners received either a print-based or video-based lesson. Upon completion of the lesson, learners completed a questionnaire on the amount of mental effort that they perceived they invested in the learning task, and then were given an achievement test. Salomon found that students rated television as easier than print. Learners in the print condition reported investing more mental effort and had higher achievement scores than students who received the video lesson. Salomon concluded that the learners' preconceptions of television as an easy medium influenced the mental effort expended in processing the television lesson.

In Kozma's (1991) review of the literature on learning with media, he points to gaps in the research on learning from television and implies the need for the development of a theoretical model of television learning. As an initial step in the process, and toward that end, this paper explores the theoretical and research basis for the relationship between learners' preconceptions of television and the amount of mental effort invested in learning from a video-based lesson.

Salomon (1983) defines the construct of "mental effort " as the "number of non-automatic elaborations applied to a unit of material" (p. 42). The conscious, purposeful processing that results from increased mental effort is assumed to create greater activation of the learner's mental schemata. According to information processing theory, a schema is an organized network of knowledge that includes concepts, facts, skills, and action sequences organized in such a way that the individual elements can be stored and retrieved in terms of a more inclusive concept (Gagné & Glaser, 1987). As new information is received, the new information cues the retrieval of related prior knowledge stored in the learner's schemata. Through the process of elaboration, the learner makes connections between the new information and information retrieved from prior knowledge (E. Gagné, 1985). The increased contact with the learner's mental schemata that results from the conscious, non-automatic generation of elaborations, or mental effort, is presumed to facilitate the retention and retrieval of the new material. In contrast to automatic processing that is fast and effortless, non-automatic processing is deliberate, conscious, and very much under the control of the individual. Salomon's (1983b; 1984; Salomon & Leigh, 1984) findings of a significantly correlation between the amount of mental effort learners reported investing in a lesson and learners' preconceptions of the medium of presentation suggest that preconceptions of the processing requirements of video may influence the actual mental effort expended in learning from a video-based lesson.

This paper presents a model of the influence of learners' preconceptions on the amount of mental effort invested in learning from television. The proposed model suggests that learners' preconceptions are influenced by the characteristics of the media, the characteristics of the task, and the characteristics of the learner. The following sections will review the theoretical and research basis of these proposed relationships, present the practical implications of the current evidence in the area, and suggest an agenda for further research.

Insert Figure 1 about here

Preconceptions of Media

Weiner (1985) proposed that learners' perceptions of the ease or difficulty of learning from a particular medium may influence the amount of effort invested in the learning task. Weiner contended that individuals engage in tasks in order to gain information about their ability. Individuals seem to work best at tasks of intermediate difficulty because engaging in difficult tasks provides little information about their ability and may be perceived as a waste of effort, while easy tasks also provide little information about their ability and are perceived as unnecessary for success. When faced with tasks that learners perceive to be of intermediate difficulty, some individuals may exert a maximum of effort. This theory may account for Salomon's (1983b; 1984; Salomon & Leigh, 1984) findings that learners reported investing less mental effort in learning from a video-based lesson that was perceived as easy than from a print-based lesson that was perceived as more difficult (than the video-based lesson).

The results of Salomon and Leigh's (1984) investigation of the responses of high and low ability students to a television and print lesson lends credence to the idea that preconceptions of the effort required to process a lesson influence the actual effort expended in learning from the lesson. Salomon and Leigh presented learners with a television and print version of a story. Consistent with earlier findings, they found that the amount of mental effort reported by the TV group was significantly lower than that reported by the print group. In addition, high-ability students reported investing significantly less effort than the low-ability students in processing the televised story. Correspondingly, the high-ability students who viewed the televised version recalled significantly less than the low-ability students who viewed the same TV story and significantly less than the high-ability students that were exposed to the print version. Weiner's theory suggests that the low-ability students may have perceived the task of learning from television as of intermediate difficulty and thus exerted a maximum of effort, while those of high-ability may have perceived the televised lesson as too easy to provide them with additional information about their ability. Weiner's theory suggests that if learners can come to view television as worthy of the exertion of additional mental effort, or moderately difficult, then they will exert a maximum of effort.

Researchers who have investigated the nature of learners' preconceptions of video-based materials have questioned them on the perceived ease or difficulty of learning from several forms of media, the amount of effort they usually invest in processing mediated materials, their media preferences, and their perceptions of the potential of various media for facilitating learning. Several researchers have concluded students in grades three though ten perceive television to be significantly "easier" than print (Krendl, 1986; Salomon, 1983b; 1984; Salomon & Leigh, 1984) and computers and writing (Krendl, 1986).

However, there is some evidence that learners' preconceptions of media vary with the age and experience of the learner. Using methodology that was similar to that used by Krendl (1986), Cambre (1991) found that the media preferences of inservice teachers differed from younger students: whereas teachers preferred reading and

watching television to using a computer and writing, students in grades three through ten preferred television watching and using a computer to reading and writing. Bordeauz and Lange (1991) found that the amount of effort children reported investing in children's programs decreased as the age of the viewer increased. As children became older, they may have become more proficient in processing children's television programs and, thus, reported the need to invest less effort than younger children.

Using a questionnaire that was modeled after Salomon's (1983; 1984), Cennamo, Savenye and Smith (1991) also found evidence that age and experience may influence learners' preconceptions of the ease of learning from a medium. They examined the preconceptions of pre-service teachers regarding the ease of learning from several forms of video-based instruction. The data analysis indicated that television was perceived to be significantly more difficult than instructional television and interactive video, and instructional television was perceived to be significantly more difficult than interactive video. Although these results were surprising in light of previous findings regarding the perceived ease of television viewing, the past academic successes of the learners and their major area of study may have provided the preservice teachers with greater insight into the learning process than the younger students who participated in earlier studies.

Kunkel and Kovaric (1983) provided evidence that learners may have different preconceptions of educational materials than they have of entertainment materials. College students reported investing significantly more mental effort in processing a television program that was designed for a Public Broadcasting Station (PBS) than in processing a program that was designed for a commercial television station. Kunkel and Kovaric reported that the majority of PBS programs are more serious and educational than commercial television programs, and the results of this study suggest that the students' perceptions of the effort required by the two types of programs may have been influenced by an awareness of this difference.

Several researchers suggest that the content of the television program may influence learners' perceptions of the effort required to process the program. Salomon (1983) questioned college students on the amount of mental effort generally expended on televised and printed adventure, sports, news, science, and crime stories. He found that, with the exception of the news, the estimated amount of invested mental effort was lower with television than with print. Using Salomon's questionnaire, Beentjes (1989) found that Dutch children did not always perceive it to be easier to learn from television than from books; instead, he found that students' ratings of the ease or difficulty of learning from a particular medium was strongly dependant on the topic in question. For example, the Dutch children perceived that it was easier to learn soccer rules from television than from a book, but felt that it was easier to learn to solve math problems from a book than from television.

Cennamo (1992) investigated learners' preconceptions of the ease of achieving various learning outcomes (psychomotor, affective, verbal, intellectual) through the media of interactive video, computers, television and books. The results indicated that there was a strong interaction between the presentation medium and the domain of the target learning outcome. Like the sixth-grade Dutch students who participated in Beentjes's (1989) study, the undergraduate students who participated in this study did not perceive it to be consistently easier to learn from television than from books. Although television was rated as easier than books for learning psychomotor skills and attitudes, books were rated as the easier medium for learning intellectual skills and verbal information. The overall means for television and computers suggested that they were perceived as very similar in ease of learning; however, an examination of the individual means for each domain indicated that television and computers were believed

to facilitate the ease of learning very different types of skills. Whereas students perceived it to be easier to learn attitudes and psychomotor skills from television, they perceived it to be easier to learn intellectual skills and verbal information from computers.

In general, research on learners' preconceptions of television and video indicates that learners perceive television as an easy medium, they feel it requires little mental effort, and they believe they would learn little from a video-based lesson. However, learners' preconceptions of media may change as they become more experienced. Learners' preconceptions of the ease of learning from television also may vary depending on the content presented through the medium.

Mental Effort

Several researchers (Britton, Muth, & Glynn, 1986) have noted that the terms mental effort, attention, concentration, use of cognitive capacity, and mental workload all refer to similar concepts and refer to an increase in the cognitive resources devoted to processing the stimulus. Methods of assessing mental effort and similar constructs fall into three main categories: opinion measures, dual tasks techniques, and physiological measures. Opinion measures encompass the variety of self-report measures used to assess mental effort. Opinion measures assume that the investment of effort is a voluntary process which is under the control of the individual, and as such, is available for introspection. Dual task techniques encompass a range of methods which assign the learner a primary task such as reading a passage, working a problem, or viewing a videotape, and also assign the learner a secondary task such as responding to a tone, finger tapping, or estimating a time internal. Dual task techniques assume that there is a limit to the learner's cognitive capacity, and when a great deal of cognitive capacity is consumed by the primary task, there will be less capacity left to devote to the secondary task. Dual task techniques assume that the differences between performance on a baseline measurement of the secondary task and performance under experimental conditions is an indication of the amount of effort expended on the primary task. Physiological measures are based on the assumption that there is a physiological response to increases in effort expenditure. The difference between a learner's baseline measurement of the physiological process and a measurement taken while the learner is performing some task is assumed to be reflective of the amount of effort the learner is investing in the task.

Researchers have investigated factors that contribute to the effort invested in video-based materials using a variety of assessment techniques and found that the amount of mental effort invested in a video-based lesson can be influenced by several motivational and cognitive factors. In a series of studies, Salomon (1983; 1984; Salomon & Leigh, 1984) used self-report questionnaires to assess the amount of mental effort that learners perceived they had invested in processing television and print-based lessons. He consistently found that students reported investing less effort in processing a video-taped version of a story than in processing a text-based version. In addition, students who were instructed to learn from the story reported investing more effort in processing the story than those who were instructed to read or view the story for fun (Krendl & Watkins, 1983; Salomon & Leigh, 1984). Salomon concluded that learners' preconceptions of the effort required by television and print and the perceived purpose of the task seemed to influence the effort invested in learning from the television or print-based lesson.

Several other studies suggest that the complexity of video-based materials may influence the effort expended in processing a lesson. The complexity of a video-based lesson may be caused by a) perceptual factors such as the simultaneous presentation of congruent or incongruent audio and video information or b) message-related factors such as the organization of the content.

Research suggests that simultaneously attending to auditory and visual information requires that cognitive resources be devoted to the process. Learners invest more effort in processing video-based materials that present information through both the auditory and visual channels than through either channel alone (Reeves, Thorson, & Schleuder, 1985). In addition, learners exert more effort in learning from materials that contain a high degree of correspondence between the information presented through the audio and video channels than they do in learning from materials in which there is little correspondence between the video and auditory information or in which there is only a thematic match between the two channels of information (Grimes, 1990).

Using a secondary task technique to assess mental effort, Reeves and Thorson (1986) found that cues occurring during a complex moment in a television commercial elicited longer reaction times than cues that occurred during less complex moments. Complexity involved both auditory elements such as the sentence syntax and visual elements such as pans, zooms, and movement within the scene. Likewise, Lang, Strickwerda, and Sumner (1991) found that learners used more mental effort in processing video cuts that were unrelated to the prior scene than in processing cuts which were related to the previous scene through visual elements or narration. The increases in effort expended during complex moments such as these may result from the need for learners to search their memories for appropriate schemata in which to store the new information. The memory search required to make sense of new information may account for the increases in effort documented by these researchers.

However, videotaped messages that contained a large number of complex elements produced faster reaction times than messages that were less complex (Reeves & Thorson, 1986). These findings suggest that learners expend more mental effort in processing messages that are simple, overall, than in processing complex messages. The researchers suggest that when processing complex messages, the viewers may be unable to call upon appropriate schemata. Simple messages may allow the viewers to easily call upon appropriate schemata, and thus, to actively engage in the process of elaboration.

The influence on mental effort of the learners' ability to call upon appropriate schemata was investigated by Meadowcroft and Reeves (1989). They classified children into those with "high schema development" and "low schema development". Using a secondary task technique to determine the amount of cognitive resources invested in the task, these researchers presented children with cartoons in a jumbled or normal form. Children that appeared to have well developed schema exerted less effort in processing the content of the programs than those who had low levels of schema development. It is possible that children with high schema development were able to call upon an appropriate schema more readily and to fill gaps in their schemata more effectively than those with less well developed schemata. The effect of story structure was nonsignificant; however, all students allocated more effort in attending to information that was central to the story content than in processing other peripheral information. Meadowcroft and Reeves concluded that children in the high schema group allocated their cognitive resources strategically, investing more effort when attending to a scene when it was central to the story content that to scenes that were incidental to the story content.

Mental Effort and Achievement

The results of research on mental effort and achievement indicates that there may not be a linear relationship between learners' invested mental effort and their achievement scores. Under certain conditions, increased effort may result in increased achievement. Yet, under other conditions, increased effort does not result in achievement gains.

When additional resources need to be devoted to perceptual processing in order to "make sense" of the information, increased effort does not always result in increased achievement. For example, Reeves, Thorson, and Schleuder (1985) presented learners with a videotaped program under audio-only, video-only, or audio-video conditions and found that reaction times to a secondary task were significantly delayed for those who attended to the audio-video presentation. However, there were no significant differences in learners' achievement scores among the three groups.

In other studies, increases in mental effort may have been accounted for by the effort required to search long-term memory for appropriate schemata in which to store the new information and, thus, may not have resulted in increased achievement scores. Lang, Strickwerda, and Sumner (1991) found that learners exerted more effort in processing video segments that included unrelated cuts representing changes in content than they did in processing segments that included related cuts linking information to new content through visual elements or narration. However, learners recalled more of the information surrounding related cuts than surrounding unrelated cuts. It is possible that when the learners were presented with an unrelated cut, they devoted additional cognitive resources to the search for relevant schemata in which to store the new information and, thus, missed the content necessary to perform well on a test of information surrounding the unrelated cuts.

Salomon (1983b) suggests that when a lesson is drastically inconsistent with learners' schemata, increased mental effort is not sufficient for increased achievement. He found that students who viewed a scrambled version of a videotaped program reported investing more mental effort in the program than students who viewed a normal version; however, they performed poorer than the students who viewed the normal program. Salomon's study (1983) suggests that simply expending more effort does not guarantee increased achievement when learners are unable to create a coherent mental model of the content. However, when Krendl and Watkins (1983) presented learners with a videotape which included irrelevant segments but retained the original narrative, learners attempted to assign meaning to extraneous scenes and to incorporate irrelevant information into the story line. In Krendl and Watkins' study, the availability of a main intact narrative apparently provided the structure necessary to tap into the viewer's schemata. In Salomon's study, self reports of increased mental effort indicated that the learners did attempt to elaborate on the material, but their lower performance suggests that they may have been unable to fit information into their existing schemata.

However, increased effort also has been shown to result in increased achievement. Grimes (1990) presented learners with three versions of a videotaped program and found that learners' reaction times to a secondary task were longest in the condition where the visual and auditory channels presented corresponding information (high correspondence), and shortest in the condition where there was only a thematic match between the visual and the audio portion of the program (medium correspondence). Scores on a visual recognition test followed the same pattern; learners who viewed the program with high correspondence scored highest and those who viewed

the program with medium correspondence scored lowest. The presence of auditory and visual information with a high degree of correspondence may have provided the best conditions under which to elaborate on the content, thus explaining why learners who received this program achieved higher test scores.

Some researchers (Krendl & Watkins, 1983; Salomon, 1983b; Salomon, 1984; Salomon & Leigh, 1984) suggest that the benefits of increased mental effort may not be evident on a test of factual recall, but instead result in greater inferences. Holmes (1987) explains that "whereas factual recall involves understanding explicitly stated information, inferences require the reader to fill in missing information or to connect propositions in the text implied by the author" (p.14). Since Salomon (1981) defines mental effort as the number of "non-automatic elaborations" applied to a unit of material, and the inference process involves conscious elaborations of the material, it seems logical that inference questions may be a more sensitive measure of increased mental effort than recall or recognition tasks. Using self-report questionnaires, Salomon (1983b; 1984; Salomon & Leigh, 1984) and Cennamo, Savenye and Smith (1991) found a significant correlation between learners' reported mental effort and their scores on a test of inference items. Learners' who reported investing a large amount of mental effort received higher inference test scores than learners who reported investing less effort.

Influential Factors

The previous section described the proposed relationships among learners' preconceptions of the ease or difficulty of a medium, the amount of mental effort they invest in processing a lesson using that medium, and their resulting achievement scores. Given these relationships, the real questions remain: Why do learners perceive one medium as easier or more difficult than another for learning a particular lesson? What can be done to overcome learners' perceptions that television is an easy medium requiring very little investment of mental effort? What factors can influence learners to invest the optimum amount of mental effort in a learning task? And finally, how can we design more effective video-based materials?

In examining the literature to seek answers to these issues, several themes seem to emerge; factors which influence learners' preconceptions of the effort required by video-based materials and their actual or perceived mental effort expenditure seem to fall into the categories of characteristics of the media, characteristics of the task, and characteristics of the learners.

Characteristics of the Media

Several characteristics of video-based lessons have been shown to influence the amount of effort that learners perceive is needed and the actual effort invested in processing a video-based lesson. Several researchers have shown that the symbol systems employed by the medium influence effort (Reeves, Thorson, & Schleuder, 1985; Salomon, 1983b; Salomon, 1984; Salomon & Leigh, 1984). The perceptual complexity of the scene changes (Lang, Strickwerda, & Sumner, 1991; Reeves & Thorson, 1986) and the degree to which the audio and video elements are parallel (Grimes, 1990) may influence the effort required to search long-term memory for an appropriate schema and to elaborate on the content of the lesson. In addition, effort investment is influenced by the structure of the video-based lesson. The importance of a segment to the story line (Meadowcroft & Reeves, 1989) influences the way learners allocate their mental effort while processing a video-based lesson.

Characteristics of the Task

Several studies have varied the characteristics of the task in order to investigate the effects on learners' preconceptions of the effort required by video-based instruction and the amount of mental effort invested in such a task. Learners seem to exert more mental effort in a lesson from which they are told to learn than from a lesson they are told to view for fun (Krendl & Watkins, 1983; Salomon & Leigh, 1984). Likewise, learners report investing more mental effort in attending to educational television programs than in attending to commercial television programs (Kunkel & Kovaric, 1983). The domain of the desired learning outcome (Cennamo, 1992) and the topic of the lesson (Beentjes,1989) also seem to influence learners' preconceptions of the effort required by video-based instruction.

Characteristics of the Learner

The preconceptions that learners bring to an instructional situation regarding the amount of effort required by a video-based lesson and the actual amount of effort expended in processing the lesson are also influenced by individual characteristics of the learner. Research suggests that the age and experience of the learners may affect their media preferences (Cambre, 1991), the amount of effort they report investing in viewing a television program (Bordeaux & Lange, 1991), and the perceived ease of learning from a video-based lesson (Cennamo, Savenye, & Smith, 1991). In addition, there is other research which suggests learners' attitudes toward a medium might change as they gain more experience with that medium (Cambre, 1991; Cennamo, 1992). The amount of effort invested in a video-based lesson also may depend on the intellectual ability of the learner (Salomon & Leigh, 1984).

Summary

This paper has proposed a direct relationship between learners' preconceptions of the effort required to process a video-based lesson, the actual mental effort expended in processing the lesson, and learners' scores on achievement tests. It proposed that learners assess a learning situation in terms of the task at hand and the medium of presentation. They make a decision as to the ease or difficulty of the task based on their past experience with similar events. They decide to exert a certain amount of effort in processing the lesson. If characteristics of the lesson differ from those expected based on past experience (i. e. harder content, more complex visually) the learners reanalyze the situation and make "on-line" modifications of their effort expenditures. The amount of actual effort invested in the task may be influenced by cognitive activities such as perceptual processing, searching memory for appropriate schemata, or elaborating on the content. Increases in effort which result from the elaboration process may result in increased contact with the learners' mental schemata and facilitate retention and retrieval of the new material. There are several practical implications of the proposed model, yet, there are numerous questions which remain to be answered. The following sections will present practical suggestions which arise from research in this area and suggest areas for further study.

Practical implications

An awareness of factors which affect learners' preconceptions of video and the amount of mental effort invested in video-based materials can assist instructional designers in creating more effective video-based lessons. Techniques as simple as informing the users that the materials are designed to be educational (Kunkel & Kovaric, 1983) and they are to learn as much as possible from the lesson (Krendl & Watkins, 1983; Salomon & Leigh, 1984) should increase the effort invested in learning from a

video-based lesson. In addition, designers should attempt to use the medium of presentation which is most appropriate for the domain of the target learning outcome (Cennamo, 1992).

The challenge for instructional designers is to maximize the effort that learners expend on elaborating the content, while minimizing the effort required to "make sense" of the content or to search long-term memory for an appropriate schemata in which to store the new material. The research suggests that the complexity of the message should be reduced through the use of simple syntax (Reeves & Thorson, 1986) and related cuts (Lang, et. al., 1991). The program should be designed so that there is a high degree of correspondence between the video and audio portions of the program (Grimes,1990). In addition, the intended message should be central to the story content (Meadowcroft & Reeves, 1989). Programs which provide pauses following complex elements such as unrelated scene changes, videographics, and complex sentences may provide time for the viewers to search their long-term memory for appropriate schemata before additional critical information is presented. Music, explanatory examples, and other mentally undemanding content may be used to allow the learners time to prepare to elaborate on new content information.

Although the instructional designer can not affect the age, experience, or ability of the learners, an awareness of such learner characteristics may assist the designer in creating a greater match between characteristics of the video-based materials and the learner. High-ability learners may need to perceive a video-based lesson as challenging in order to perceive it as necessary to gain information about their ability (Salomon & Leigh, 1984; Weiner, 1985).

Topics for Further Research

It has been suggested that learners' preconceptions of the effort required by a learning task are influenced by the characteristics of the media, characteristics of the task, and characteristics of the learner. These conclusions are based on learners' self-reports of their perceptions of media. Future research needs to examine the reasons why learners perceive one medium as easier or more difficult than another for learning a particular task. In-depth interviews with learners regarding the reasons why they may rate one medium as easier or more difficult than another may provide insight as to other factors which may influence their preconceptions of the effort required by a particular media-based lesson.

In addition, previous investigations of the amount of effort invested in a video-based lesson may have been limited by the methodology available to assess the construct of mental effort. Early work (Salomon, 1983; Salomon, 1984; Salomon & Leigh, 1984) used self-report questionnaires to document the learners' effort expenditures. Recently, however, researchers (Beentjes, 1989; Cennamo, et. al., 1991) have identified a need for more precise methods of assessing mental effort. Validation studies where mental effort is investigated using a variety of methods may yield the research tools necessary to explore other techniques which may increase the effort expended in processing video-based lessons.

A series of studies in human factors engineering (Casali & Wierwille, 1983; Wierwille & Connor, 1983; Wierwille, Rahimi, & Casali, 1985) have attempted to determine the sensitivity of 15 different assessment measures for detecting variations in the workload placed upon an operator of a flight simulator and may serve as a model for educational researchers investigating methods of assessing mental effort. The researchers found that the assessment measures which were most sensitive to manipulations in the operator workload varied depending on the type of task performed by the operator. For example, eyeblinks and eye fixation measures were sensitive to

increases in the difficulty of a cognitive task, but were not sensitive to increases in the difficulty of a communication task. Although one of the opinion scales (Modified Cooper-Harper) and the time estimation task were sensitive to increases in operator demands across perceptual, psychomotor, communication, and cognitive problem solving tasks, the time estimation task resulted in an increase in the error rate of subjects who were performing the cognitive task. These results suggest that educational researchers who desire to assess the mental effort invested in learning tasks may need to take into consideration the type of task required of the learner and the possible interference effects of the assessment measures on the performance of the primary task.

Future research needs to continue investigating techniques that may be incorporated into video-based materials in order to increase the amount of effort invested in processing lessons presented through this medium. Due to the complexity of the symbol systems present in video-based instruction coupled with the linear, fixed pace of the presentation, it may be beneficial to include techniques that would assist the learner in actively processing the content in a more efficient manner. Techniques designed to facilitate the learners' search for appropriate schemata and to enhance their abilities to elaborate on the content may overcome the learners' potential conflict between attending to new information as it is being presented, conducting a memory search to activate appropriate schemata, or elaborating on the content. Techniques that cue the learners in advance as to the appropriate schema to engage or that allow the learners extra time to actively process new information may increase the mental effort that learners invest in processing a video-based lesson and, thus, increase the amount of information learned from the lesson.

Britton and his colleagues have varied the structure of text-based materials to determine the effects of various techniques on learners' invested mental effort. Using a secondary task method of assessing mental effort, they found that the amount of effort expended in reading text passages was influenced by the meaningfulness of the passage (Britton, Holdredge, Curry, & Westbrook, 1979), the learners prior knowledge of the content (Britton & Tesser,1982), the importance of the information (Britton, Muth, & Glynn, 1986), the style of writing (Britton, Graesser, Glynn, Hamilton, & Penland, 1983), embedded questions (Britton, Piha, Davis, & Wehausen, 1978), text syntax (Britton, Glynn, Meyer, & Penland, 1982) and the presence of objectives (Britton, Glynn, Muth, & Penland, 1985). It may be useful to incorporate similar techniques into video-based materials to determine if such factors influence the processing of text-based and video-based materials in a similar manner.

Future research also should investigate the effects of the enhanced processing capabilities offered by computers on learners' preconceptions and mental effort. The symbol systems available for books and television are very similar to those commonly available via computers and interactive video and it could be argued that interactive video and computer-based instruction are sophisticated variations of television and books with enhanced processing capabilities. Although many elaborate techniques for enhancing instruction are available through the addition of the computer, computer-aided instruction, at its most basic level, offers computer-controlled text and interactive video offers computer-controlled video.

Finally, the proposed link between learners' preconceptions of the effort required by a medium, the actual effort expended, and learners' achievement scores must be investigated in a systematic fashion. For example, the domain of the intended learning outcome seems to influence learners' perceptions of the ease of learning from a television lesson (Cennamo, 1992). Learners report that it is easier to learn psychomotor skills and attitudes from television than from books, but that it is easier to learn verbal information and intellectual skills from books than from television. In

order to continue an investigation of the proposed relationships among learners' preconceptions, mental effort, and achievement, future research should investigate a) whether students actually invest more mental effort or learn more when instructed in psychomotor skills and attitudes through television than through print-based instruction, and b) whether learners invest more mental effort in learning psychomotor skills and attitudes from television than in learning verbal information and intellectual skills from television.

This review of the literature on preconceptions of video-based instruction and mental effort has also identified several areas in which there has been little research. Future research should investigate the influence of individuals' learning styles on their preconceptions of the ease of learning from media, the amount of mental effort invested in learning from a video-based lesson, and their learning achievement. In addition, the reciprocal relationship between learners' experiences of success or failure in learning from a video-based lesson and their subsequent perceptions of the ease or difficulty of learning from the medium in the future should be investigated. Salomon (1981) reminds us that mental effort has motivational as well as cognitive components; therefore, future research should incorporate techniques intended to increase learners motivation into video-based instruction to determine the effects of these techniques on mental effort and achievement.

This paper has reviewed the current research literature and outlined factors that must be considered in future investigations of learners' preconceptions of video-based instruction, the mental effort invested in learning from such a lesson, and techniques to increase the effort invested in processing a video-based lesson. The results of this research should provide instructional designers, video producers, and teachers with practical means of increasing the effort that learners spend in processing video-based materials so that the ultimate goal of the designer, the producer, the teacher, and the learner can be met as efficiently and effectively as possible- that of the achievement of the desired learning outcomes.

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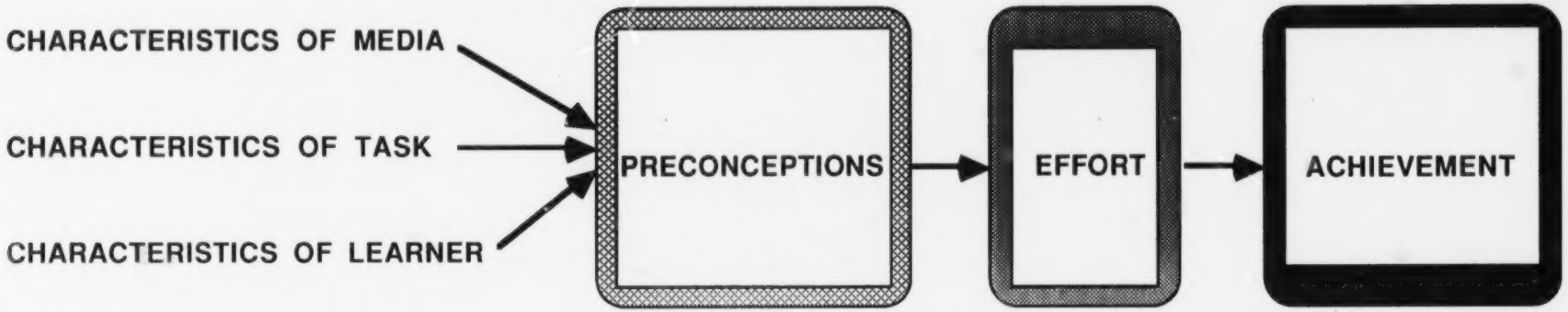
CHARACTERISTICS OF MEDIA
CHARACTERISTICS OF TASK
CHARACTERISTICS OF LEARNER
PRECONCEPTIONS
EFFORT
ACHIEVEMENT

Figure 1